



Community-based Services that Facilitate Interoperability and Intercomparison of Precipitation Datasets from Multiple Sources

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ABSTRACT

Over the past 12 years, large volumes of precipitation data have been generated from space-based observatories (e.g., TRMM), merging of data products (e.g., 3B42), models (e.g., GMAO), climatologies, field campaigns, and ground-based measuring stations. The science research, applications, and education communities have greatly benefited from the unrestricted availability of these data from the Goddard Earth Sciences Data and Information Services Center (GES DISC) and, in particular, the services tailored toward precipitation data access and usability. In addition, tools and services that are responsive to the expressed evolving needs of the precipitation data user communities have been developed at the Precipitation Data and Information Services Center (PDISC), located at the GES DISC, to provide users with quick data exploration and access capabilities.

In recent years, data management and access services have become increasingly sophisticated, such that they now afford researchers, particularly those interested in multi-data set science analysis and/or data validation, the ability to homogenize data sets, in order to apply multi-variant, comparison, and evaluation functions. Included in these services is the ability to capture data quality and data provenance. These interoperability services can be directly applied to future data sets, such as those from the Global Precipitation Measurement (GPM) mission.

This presentation describes the data sets and services at the PDISC that are currently used by precipitation science and applications researchers, and which will be enhanced in preparation for GPM and associated multi-sensor data research. Specifically, the GES-DISC Interactive Online Visualization ANd aNalysis Infrastructure (Giovanni) will be illustrated. Giovanni enables scientific exploration of Earth science data without researchers having to perform the complicated data access and match-up processes. In addition, PDISC tool and service capabilities being adapted for GPM data will be described, including the Google-like Mirador data search and access engine; semantic technology to help manage large amounts of multi-sensor data and their relationships; data access through various Web services (e.g., OPeNDAP, GDS, WMS, WCS); conversion to various formats (e.g., netCDF, HDF, KML (for Google Earth)); visualization and analysis of Level 2 data profiles and maps; parameter and spatial subsetting; time and temporal aggregation; regridding; data version control and provenance; continuous archive verification; and expertise in data-related standards and interoperability. The goal of providing these services is to further the progress towards a common framework by which data analysis/validation can be more easily accomplished.

Interoperability

Services are available at GES DISC to support data interoperability:

- OPeNDAP (<http://disc.sci.gsfc.nasa.gov/services/opendap/>)
- NetCDF conversion : on-the-fly for some datasets (<http://disc.sci.gsfc.nasa.gov/services/NetCDFConversionforIDVandMcIDAS-V.shtml>)
- OGC web map server (http://disc.sci.gsfc.nasa.gov/services/ogc_wms/wxs_ogc.shtml)
- Data read software and HDF tools (<http://disc.sci.gsfc.nasa.gov/services/tools/tools.shtml>)

ARMOS COMPOSITION

HYDROLOGY

A-TRAIN

AMS

MODELING

MAERS

PRECIPITATION

GES DISC

Goddard Earth Sciences Data and Information Services Center

DATA AVAILABLE VIA OPeNDAP (OPeNDAP)

The Open Source Project for a Network Data Access Protocol (OPeNDAP) provides remote access to individual variables within datasets in a form usable by many tools, such as IDV, GrADS, or IDV Ferret, and in a variety of formats. Currently, the GES DISC offers the following datasets through OPeNDAP (NLS, not an OPeNDAP observation set as of 10/10/05):

Atmospheric Infrared Sounder (AIRS) Moisture, Temperature, Cloud and Trace Gases

Visible, Infrared and Microwave sensors provide daily global temperature profiles with accuracy of 1.5 K in the lower troposphere (20-60% in the upper troposphere).

Visible IR also includes profiles of CO and CH₄ in addition to total column of ozone, CO and water vapor, cloud height and cloud fraction, and other atmospheric derived parameters.

Deep Layer temperatures and ozone: precipitation rates derived from 16 years of measurements taken by the Microwave Sounding Unit (MSU) from aboard NOAA's Polar-orbiting Operational Climate Satellites (POCS).

The Tropical Rainfall Measuring Mission (TRMM) Global Rainfall Data

TRMM is dedicated to measuring tropical and subtropical rainfall through microwave and visible infrared sensors, and includes the first space borne rain radar. The TRMM orbit is circular, non-inclined, at an altitude of 370 km and inclination of 35 degrees to the Equator, providing extensive coverage in the tropics.

Total Column Mapping Spectrometer (TOMS) Daily Global Ozone Data

Since 1978 TOMS has been flown on number of spacecrafts for monitoring global and regional trends in total ozone. It has provided long-term (45 yrs) continuous record of total ozone. TOMS also provided measurements of atmospheric aerosols, volcanic SO₂, ultraviolet irradiance, ethylene UV exposure, and effective surface reflectivity.

Cross-Mission Instrument Daily Global Ozone Data

OMI is a dual instrument from July 2004 on the EOS-Aura spacecraft (operational around 1.50 PM in ascending mode) to continue the monitoring of global total ozone. OMI also provides the major atmospheric pollutants: tropospheric ozone, nitrogen dioxide, sulfate dioxide, ammonia, formaldehyde in addition to CO, ethylene, sulfur UV radiation, and clouds.

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FAO

Science Team Portal (Restricted Access)

GES DISC

Goddard Earth Sciences Data and Information Services Center

DATA AVAILABLE VIA OGC WEB MAP SERVICE

The Open Geospatial Consortium (OGC) Web Map Service (WMS) is an interface that allows the use of data and enables clients to build customized maps with data coming from different networks.

The GES DISC provides the following data through the WMS interface:

Atmospheric Infrared Sounder (AIRS) Real-Time

107, 302 (in addition to volcanic SO₂, CO₂, and CO) are available to the user through the GES calculated Balance data.

Atmospheric Infrared Sounder (AIRS) Data Products

Visible, infrared and microwave sensors provide daily global atmospheric temperature, moisture and trace gases parameters through the atmosphere. AIRS MYRS layers include surface temperature, total column ozone, CO and water vapor, cloud fraction, and other atmospheric derived parameters.

The Tropical Rainfall Measuring Mission (TRMM) Global Rainfall Data

TRMM is dedicated to measuring tropical and subtropical rainfall through microwave and visible infrared sensors, and includes the first space borne rain radar.

How does it work?

OGC WMS interacts with the clients via the HTTP protocol. In most cases, a WMS is a CGI program. The WMS specification defines a number of request types, and for each of request type a set of query parameters and associated behaviors. Listed below are the requests available from the WMS:

GetCapabilities: return an XML document with metadata containing Web Map Service information.

GetMap: return an image as specified by a user.

GetLegendGraphic: return a legend image (color bar) for the requested layer.

Valid GetMap Request According to the WMS Specification

Version: Required. Request version.

Request: Required. Request name.

Layers: Required. List of one or more layer names.

Stylename: Optional. Style Reference System.

Dimensions: Optional. Dimensions (lower left, upper right) in SRS units.

Precipitation and Other Datasets from Multiple Sources

Mirador

Data Access Made Simple

You are here: [Project](#) > [TRMM](#)

Keyword

Projects

Science Areas

TRMM

The Tropical Rainfall Measuring Mission (TRMM) is a joint endeavor between NASA and Japan's National Space Development Agency. It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation, shaping both global weather and climate.

Data Group

	Description	Date Range
Auxiliary	TRMM Auxiliary data products	2000-02-07 to 2010-11-30
Gridded	Gridded data products from VRS, TM, and PR, at a range of spatial and temporal resolutions	1997-12-01 to 2010-11-01
Ground-based Instrument	Ground-based instrument data products	1995-01-01 to 2010-05-31
Orbital	Orbital data products from VRS, TM, and PR, at the sensor's resolution	1997-12-01 to 2010-11-30
Subset	Parameter, gridded, regional gridded, and coincidence subset data derived from TRMM standard data products	1993-01-01 to 2010-11-30

1. AIRS Real-Time Data (AIRS)

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Above left: Precipitation products in Mirador (<http://mirador.gsfc.nasa.gov/>). **Above right:** TRMM orbital data products.

Precipitation Data Product Intercomparison and Exploration

<http://disc2.nascom.nasa.gov/Giovanni/tovas/>

The ability to compare precipitation data products from multiple sources is important to understand differences among products and improve future products. The TRMM Online Visualization and Analysis System (TOVAS), as a member of the Giovanni family, can provide customized analysis and more for intercomparison, comparing to existing similar services.

Giovanni allows a quick and easy access to visualization and analysis of NASA and other data products without data and software downloading. With Giovanni, users can conduct investigations using data from multiple sensors and from different sources.

TOVAS and Giovanni can be applied to and enhanced for GPM.

Left:

An instance of precipitation product intercomparison. Three products from different sources (satellites, radars and gauges) are listed here. Functions that reveal their relationships are listed as well. More precipitation products can be added as well as additional functions or algorithms, such as those used by IPWG members. Instances of products in different temporal and spatial resolutions can be developed as well.

TRMM TMPA-RT Rain Rate [mm/day]

(30Aug2005)

West Longitude: -130 East Longitude: -50 North Latitude: 20 South Latitude: 20

Select one or more parameters for Lat/Lon Map or Time Series.

Select two parameters for any Plot Type of Inter-comparison.

To de-select a parameter, use Ctrl-Click.

Product 1: 2005/01/02 - 2005/12/31

Product 2: 2005/01/02 - 2005/12/31

Plot Type: Lat/Lon Map

Begin year: 2005/01/02 End year: 2005/12/31

Data Begin: 2005/01/02 Data End: 2005/12/31

Color Options:

Time Series Plot

Y-Axis Options:

ASCII Output Resolution (x): 0.25x0.25

Generate Plot ASCII Output Reset Form

Daily Rain [mm/day]

(30Aug2005)

Daily Radar Rain Data [mm/day]

(30Aug2005)

Above: Examples of the daily rainfall intercomparison during the Hurricane Katrina event.

Flooding in Pakistan caused by above normal monsoon rainfall

Giovanni

The Bridge Between Science and Data

You are here: [GES DISC Home](#) > [Giovanni](#)

GIOVANNI

Giovanni is a Web-based application developed by the GES DISC that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data.

Giovanni is comprised of a number of interfaces, called instances, that tailored to meet the needs of different Earth science research communities. To access a Giovanni instance, click on one of the four categories below:

Atmospheric Instances:

A-Train CloudSat/Track, Aerosol Optical Thickness Measurement and Model Comparison Daily and Monthly, Aqua/IRS Global Daily and Monthly, Aura High Resolution Dynamics Limb Sounder (HIRDL), Aura Microwave Limb Sounder (MLS), Aura OMI Level 3 and Level 2S, MODIS Daily and Monthly, Clouds and the Earth's Radiant Energy System (CERES FM4), Modern Era Retrospective-Analysis for Research and Applications (MERRA), 20-Monthly and 20-Monthly, MODIS Terra and Aqua Daily and Monthly, Northern Eurasia Earth Science Partnership Initiative (NEESPI) Daily and Monthly, Tropospheric Emission Spectrometer (TES), Upper Atmosphere Research Satellite (UARS) Halogen Occultation Experiment (HALOE).

Environmental Instances:

Agriculture, Air Quality, Monsoon Asia Integrated Regional Study (MAIRS) Monthly, Northern Eurasia Earth Science Partnership Initiative (NEESPI) Daily and Monthly.

Ocean Instances:

Ocean Color Radiometry (SeaWiFS), MODIS, and derived and model products Daily and Monthly.

Hydrology Instances:

Modern Era Retrospective-Analysis for Research and Applications (MERRA) 30-Monthly and 20-Monthly, MODIS Terra and Aqua Daily and Monthly, Northern Eurasia Earth Science Partnership Initiative (NEESPI) Daily and Monthly, TRMM Online Visualization and Analysis System (TOVAS), Global Land Data Assimilation System (GLDAS) Monthly.

If you already know which instance to choose, please select it from the table below.

A-Train	Aerosol Daily	Aerosol Monthly	Agriculture	Air Quality
Aqua/IRS Daily	Aqua/IRS Monthly	Aura HIRDL	Aura MLS	Aura OMI L3
Aura OMI L2Q	CERES (FM4)	GLDAS Monthly	MAIRS Monthly	MERRA MONTH 2D
MERRA MONTH 3D	MERRA MONTH ANA	MERRA MONTH CHM	MISR Daily	MISR Monthly
MODIS Daily	MODIS Monthly	NEESPI Daily	NEESPI Monthly	Ocean Color Radiometry
Ocean Model Daily	Ocean Model Monthly	TOMS	TRMM/TOVAS	TES
UARS HALOE				

During the months of July and August 2010, monsoon precipitation considerably above normal fell in Pakistan, leaving millions of people homeless and dependent on aid.

Global Merged IR (00min14212JUL2010)

Created by NASA Goddard GES DISC

TRMM TMPA-RT Daily (Lat: 28N-35N, Lon: 70E-74E)

Accumulated Rainfall [mm]

2009

TRMM TMPA-RT Daily (Lat: 28N-35N, Lon: 70E-74E)

Accumulated Rainfall [mm]

2010

TRMM TMPA-RT Daily (Lat: 28N-35N, Lon: 70E-74E)

Accumulated Rainfall [mm]

2009

TRMM TMPA-RT Daily (Lat: 28N-35N, Lon: 70E-74E)

Accumulated Rainfall [mm]

2010

Above: Other Giovanni instances containing many products from NASA and other missions/projects.

Future plans include continuous improvements and new additions of data services, documentation, data application case studies and user services based on user feedback and future mission requirements. Emphasis will be on merging, integration, and intercomparison of multi-satellite, multi-mission and multi-sensor data.

Below: A list of other data products from NASA satellite missions and other sources in Mirador. Mirador is a search and order Web interface developed in response to the search habits of data users. It has a drastically simplified, clean interface and employs the Google mini appliance for metadata keyword searches. Other features include quick response, data file hit estimator, Gazetteer (geographic search by feature name capability), and an interactive shopping cart. Value-added services include data format conversions and spatial subsetting for limited products.

Project	Description	Start Year	End Year
A-Train	Collocated with CloudSat subsets of MODIS/Aqua, AMSR-Earth, OMI/Aqua, and POLARPARASOL.	2004	2010
AIRS	The Atmospheric Infrared Sounder (AIRS) is a facility instrument aboard the second Earth Observing System (EOS) polar-orbiting platform, EOS Aqua. In combination with the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder for Broad (HSB), AIRS constitutes an innovative atmospheric sounding grid of visible, infrared, and microwave sensors. Global coverage will be obtained twice daily (day and night) on a 1.36m sun synchronous orbit from a 705-km altitude. For processing convenience, the data is divided into 6-minute files for Level 1 and 2 data. disc2/airs	2002	2010
GLDAS	The Global Land Data Assimilation System (GLDAS) is generating a series of land surface data (e.g., soil moisture and surface temperature) and flux (e.g., evaporation and sensible heat flux) products in real time. These measurements are used to derive vertical profiles of ozone, H ₂ O, water vapor, and other atmospheric trace gases. Global coverage will be obtained twice daily (day and night) on a 1.36m sun synchronous orbit from a 705-km altitude. For processing convenience, the data is divided into 6-minute files for Level 1 and 2 data. disc2/airs	1979	2010
GOCART	The Goddard Chemistry Aerosol Radiation and Transport (GOCART) model simulates major tropospheric aerosol components, including sulfate, dust, black carbon (BC), organic carbon (OC), and sea-salt aerosols. The following is a brief description of the model. The GOCART model uses the assimilated meteorological fields of the Goddard Earth Observing System Data Assimilation System (GEOS DAS), generated by the Goddard Global Modeling and Assimilation Office. The model has a horizontal resolution of 1 deg latitude by 2.5 deg longitude by 1 deg latitude, and 20-25 vertical sigma layers (depending on the version of GEOS DAS).	2000	2007
HIRDL	The High Resolution Dynamics Limb Sounder (HIRDL) aboard the EOS Aura spacecraft (launched July 15, 2004) measures infrared emission in 21 channels ranging from 6.2 to 17.2 microns. These measurements are used to derive vertical profiles of ozone, H ₂ O, water vapor, and other atmospheric trace gases. Global coverage will be obtained twice daily (day and night) on a 1.36m sun synchronous orbit from a 705-km altitude. For processing convenience, the data is divided into 6-minute files for Level 1 and 2 data. disc2/airs	2005	2008
LIMS	The Limb Infrared Monitor of the Stratosphere (LIMS) instrument measures vertical profiles of temperature, potential height, and mixing ratios of ozone (O ₃), nitrogen dioxide (NO ₂), water vapor (H ₂ O), and other atmospheric trace gases. The LIMS instrument was launched on the Nimbus-7 satellite and was operational for about seven months from 25 October 1979 until May 26, 1979.	1979	1979
MERRA	The Modern Era Retrospective-Analysis for Research and Applications (MERRA) products are generated using Version 5.2.0 of the GEOS-5 DAS with the model and analysis each at 1/2x2/5 degrees. Three-dimensional analyses are generated every 6 hours, and 3-dimensional diagnostics, describing the radiative and physical properties of the atmosphere, are hourly. The product suite includes analyses on the relative vertical grid and sea level pressure surfaces. Two-dimensional data, including surface fluxes, and vertical integrals, are produced hourly. The product suite includes monthly and monthly diurnal files. The MERRA product is being conducted in 3 separate streams, 1979-1989, 1989-1999, and 1999-present. Data are being updated to the MERRA, after undergoing quality assurance in the GMAO.	1979	2010
MLS	The Microwave Limb Sounder (MLS) aboard the EOS-Aura spacecraft (launched July 15, 2004) measures microwave emissions from the Earth's limb at 118, 180, 240 and 640 GHz, and 2.5 THz. These measurements allow MLS to derive vertical profiles of ozone, water vapor, OH, H ₂ O, CO, HNO, H ₂ O, H ₂ O, H ₂ O, H ₂ O, and SO ₂ , as well as temperature, cirrus ice, relative humidity with respect to ice, and aerosol height.	2004	2010
MSU	The Microwave Sounding Unit (MSU) scans the atmospheric column in four channels in the region of 50-60 GHz and provides daily observations of Lower Stratosphere Temperature (LST), Upper Troposphere Temperature (UTT), Lower Stratosphere Temperature (LST) and oceanic precipitation (OP). The LST channels have been replaced by the off-orbit observations. MSU has been flown on number of NOAA Polar-orbiting Environmental Satellites (POES) since 1979.	1979	1994
NEESPI	The NASA Northern Eurasia Earth Science Partnership Initiative (NEESPI) data holdings focus on collecting satellite remote sensing data from different sensors in support of the NEESPI scientific objectives.	2000	2010
ILBAS	The Northern American Land Data Assimilation System (NLDAS) provides precipitation, land-surface data (e.g., soil moisture and surface temperature), and fluxes (e.g., radiation and latent and sensible heat fluxes) by integrating observations from numerous sources combined with land-surface modeling. Phase 2 of NLDAS comprises hourly data from Jan 1979 to present (with a 2- to 5-day lag) at 1/6th-degree grid spacing over the contiguous United States and parts of Canada and Mexico.	1979	2010
OMI	The Ozone Monitoring Instrument (OMI) aboard the EOS-Aura spacecraft (launched July 15, 2004) is a wide-swath imaging spectrometer that provides daily global measurements of earth-atmosphere back scattered radiances in 1500 wavelength bands in the ultraviolet and visible spectral region (240 to 504 nm) at a spatial resolution of 13x24 km. Also once a month, OMI provides measurements in a spatial scan mode at a resolution of 13 x 24 km. These measurements are used to retrieve column amount of O ₃ , H ₂ O, SO ₂ , and Aerosol. Four of the U.S. Environmental Protection Agency's air criteria pollutants, as well as HCHO, BrO, CO, CO ₂ , Ozone Profiles, Effective Cloud Fraction and Pressure, and Surface Ultraviolet UV-B irradiance.	2004	2010
SORCE	The Solar Radiation and Climate Experiment (SORCE) mission measures the solar radiation incident at the Earth's atmosphere. Data products are available containing the total solar irradiance, and solar spectral irradiance, both at 6 hourly and daily averages.	2003	2010
SSEBV	The Shuttle Solar Backscatter Ultraviolet (SSBUV), nearly identical to Nimbus-7 SBVU and NOAA SBVU-2 instruments flown on eight space shuttle missions (1981-1989) provided earth-atmosphere backscattered radiances at 1 UV wavelengths between 252-340 nm and solar spectral UV irradiances over the wavelength range 200-480 nm with a resolution of 1 nm. Ozone profile, ozone total column, aerosol optical, effective surface reflectivity and solar spectral irradiance data retrieved from these observations were used for the validation of satellite measurements.	1989	1996
TOMS	The Total Column Mapping Spectrometer (TOMS) has been successfully flown on four satellites (Nimbus-7, Meteor-3, Earth-Probe, and ADEOS) for daily monitoring of regional and global distribution of atmospheric ozone. TOMS has provided almost 30 years (1978-2006) long-term record of atmospheric ozone observations that has helped scientists in understanding the global ozone trend, ozone hole and ozone recovery. Though TOMS was designed for ozone monitoring, it also provided valuable information on the sources of tropospheric aerosols (dust and smoke) and its long-range transport, volcanic SO ₂ , ethylene UV exposure, and effective reflectivity of the earth's surface and clouds.	1978	2005
TOVAS	The TRMM Online Visualization and Analysis System (TOVAS) provides information on temperature and humidity profiles, total ozone, clouds and radiation, as well as a global scale intercomparison of the data products using four algorithms provides a wealth of climatological information. TOVAS has been carried aboard NOAA polar-orbiting weather satellites since 1978, and continues to the present.	1978	1995
TRMM	The Tropical Rainfall Measuring Mission (TRMM) is a joint endeavor between NASA and Japan's National Space Development Agency. It is designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation, shaping both global weather and climate.	1993	2010
UARS	The Upper Atmosphere Research Satellite (UARS) data set consists of daily near global (60 to 40 degrees) measurements of atmospheric trace gases, temperature, aerosols and wind profiles, as well as measurements of solar UV spectra and charged particles injected into the Earth's atmosphere.	1991	2005

200912141311.27C.DSN.1871.94800.16109_CS_03394_3R.jpg

CloudSat ORP

TRMM PR

Left: Radar reflectivity of Cloudsat/TRMM intercepts (courtesy of the Cloudsat data processing center at Colorado State University), showing data from two different radars with different frequencies.

Above: OPeNDAP provides remote access to individual variables within datasets in a form usable by many tools, such as IDV, McIDAS-V, Panoply, Ferret and GrADS.

Above: WMS is an interface that allows the use of data and enables clients to build customized maps with data coming from a different network.

3B42: 3-Hour 0.25 x 0.25 degree merged TRMM and other satellite estimates

info

3B43: Monthly 0.25 x 0.25 degree merged TRMM and other sources estimates

info

Calibrated IR merged with TRMM and other satellite data

Available Services:

Convert to KMZ

Download via HTTP

Convert to NetCDF

Convert to gzipped NetCDF

Merged 3B42 and rain gauge estimates

Available Services:

Download via HTTP

Convert to KMZ

Convert to NetCDF

Subset Spatially and/or by Parameter as NetCDF

All services can be applied to and enhanced for GPM. New services can be developed as well

Above: Mirador also provides data services for format conversion (e.g., NetCDF, KMZ) and spatial subsetting by parameter.